Combination Scattering Meter and Fluorometer

ECO BB2F

User's Guide

This user's guide is an evolving document. If you find sections that are unclear or missing information, please let us know. Please check our website periodically for updates.

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Attention!

Return Policy for Instruments with Anti-fouling Treatment

WET Labs cannot accept instruments for servicing or repair that are treated with anti-fouling compound(s). This includes but is not limited to tri-butyl tin (TBT), marine anti-fouling paint, ablative coatings, etc.

Please ensure any anti-fouling treatment has been removed prior to returning instruments to WET Labs for service or repair.

ECO Sensor Warranty

This unit is guaranteed against defects in materials and workmanship for a period of one year after the original date of purchase. WET Labs will supply all replacement parts and labor and pay for return via 3rd day air shipping in honoring this warranty. This warranty is considered void if the factory determines that the unit was subjected to abuse or neglect beyond the normal wear and tear of field deployment, or in the event the pressure cans have been opened by the customer (this does not apply to pressure cans on battery-supplied units). The customer should call for a Return Manufacturer's Authorization (RMA) before returning the instrument to the factory and is responsible for shipping costs to WET Labs. WET Labs is not responsible for shipping damage done during the return shipment. WET Labs assumes no liability for equipment damage, personal injury or loss of data resulting from use of this instrument, except for that stated in this warranty.

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1. Specifications

Model	BB2F	BB2FB
Mechanical		
Diameter	2.48 in (6.3 cm)	2.48 in (6.3 cm)
Length	5.0 in (12.7 cm)	10.0 in (25.4 cm)
Weight in air	0.9 lbs (0.4 kg)	2.1 lbs (0.96 kg)
Weight in water	0.05 lbs (0.02 kg)	0.3 lbs (0.14 kg)
Material	ABS	ABS
Environmental		
Temperature range	0–30 deg C	0–30 deg C
Depth rating	600 m	600 m
Pressure/temperature sensor (optional)	Y	Y
Electrical		
Digital output resolution	12 bit	12 bit
Internal data logging	Yes	Yes
Internal batteries	No	Yes
Connector	MCBH6M	MCBH6M
Input	7–15 VDC	7–15 VDC
Current, typical	80 mA	80 mA
Current, sleep	85 μA	85 μA
Data memory	1 MB (50,000 samples)	1 MB (50,000 samples)
Sample rate	to 10 Hz	to 10 Hz
RS-232 output	19200 baud	19200 baud
Optical		
Scattering wavelength	470, 530, and 660 nm	470, 530, and 660 nm
Fluorometer excitation	470 nm	470 nm
Fluorometer emission	695 nm	695 nm
Sensitivity, (min.)	0.005 m^{-1}	0.005 m^{-1}
Resolution, blue	4.1×10^{-5} m^{-1}/sr	4.1×10^{-5} m^{-1}/sr
Resolution, green	5.6×10^{-6} m^{-1}/sr	5.6×10^{-6} m^{-1}/sr
Resolution, red	2.1×10^{-6} m^{-1}/sr	2.1×10^{-6} m^{-1}/sr
Linearity	99% R^2	99% R^2

1.1 Connectors

The *ECO* BB2F uses a six-pin bulkhead connector; the pin functions for this connector are shown in Figure 1. Table 1 summarizes pin functions for the bulkhead connectors.

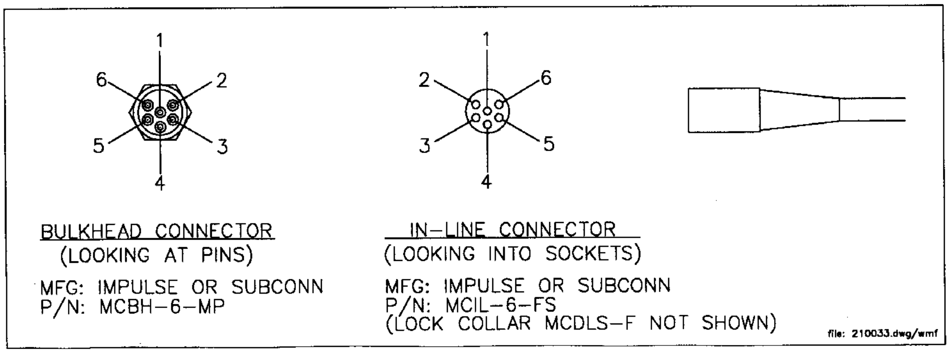


Figure 1. *ECO*-BB2F connector schematic

Table 1. Pinout summary for *ECO* BB2F connectors

Pin (or Socket)	Function
1	Ground
2	RS-232 (RX)
3	Reserved
4	V in
5	RS-232 (TX)
6	Reserved

Input power of 7.5–15 VDC is applied to pin 4. The power supply current returns through the common ground pin. The input power signal has a bi-directional filter. This prevents external power supply noise from entering into *ECO*-BB2F, and also prevents internally generated noise from coupling out on to the external power supply wire. Data is sent out the serial output pin.

1.1.1 ECO BB2FB Connectors

The *ECO* BB2FB (unit with internal batteries) has a second bulkhead connector that comes with a jumper plug to supply power to the unit. The pin functions for this connector are shown in Figure 2. Table 2 summarizes pin functions for the 3-socket bulkhead connector.

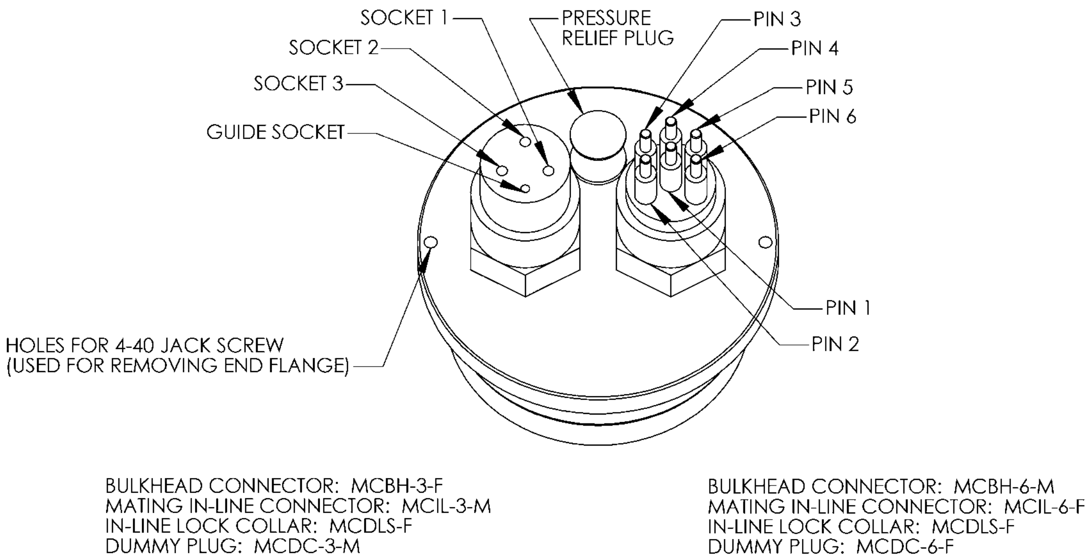


Figure 2. *ECO* BB2FB connector schematic

Table 2. Pinout summary for *ECO* 3-socket connector

Pin (or Socket)	Function
1	V in
2	N/C
3	Battery out

1.2 Test Cable

A test cable is supplied with each unit. This cable includes three legs:

1. A power interface module provides power to the instrument from either the internal battery or from an external power supply. On the test box, an RCA connector provides analog output.
2. A DB-9 serial interface connector.
3. A six-socket in-line connector plugs into the sensor to provide power and obtain signal.

1.3 Delivered Items

The standard *ECO* delivery consists of the following:

- the instrument itself
- test cable
- this user's guide
- ECOView user's guide

- ECOView host program and instrument-specific device file (on CD)
- instrument-specific calibration sheet
- protective cover for optics
- BB2F only: stainless steel mounting bracket and hardware (See Appendix A for details)
- spare parts kit for units with internal batteries:
    - jumper plug for autonomous operation
    - 2 end flange O-rings (size 224) and two vent plug O-rings (size 010)
    - 2 jacking screws for connector flange removal
    - One 3/32-in. hex key for jacking screws
    - 3 pre-cut segments (7 inches) of 0.036-inch diameter monofilament for end flange
    - 3 pre-cut segments (0.25 inch) of 0.094-inch diameter white nylon bar stock for replacing the white plastic dowel pin.

2. Theory of Operation

The *Environmental Characterization Optics*, or *ECO* miniature combination scattering meter and fluorometer allows the user to measure backscattering at two wavelengths (470 and 740 nm) at 117 degrees and chlorophyll fluorescence within the same volume. This angle was determined as a minimum convergence point for variations in the volume scattering function induced by suspended materials and water itself. Therefore, the signal measured by this meter is less determined by the type and size of materials in the water and more directly correlated to the concentration of the materials.

The *Environmental Characterization Optics*, or *ECO* miniature fluorometer allows the user to monitor chlorophyll concentration by directly measuring the amount of chlorophyll-*a* fluorescence emission from a given sample volume of water. Chlorophyll, when excited by the presence of an external light source, absorbs light in certain regions of the visible spectrum and re-emits a small portion of this light as fluorescence at longer wavelengths. The *ECO* uses two bright blue LEDs (centered at 455 nm and modulated at 1 kHz) to provide the excitation source. A blue interference filter is used to reject the small amount of red light emitted by the LEDs. The blue light from the sources enters the water volume at an angle of approximately 55–60 degrees with respect to the end face of the unit. Fluoresced light is received by a detector positioned where the acceptance angle forms a 117-degree intersection with the source beam. A red interference filter is used to discriminate against the scattered blue excitation light. The red fluorescence emitted is synchronously detected by a silicon photodiode.

The *ECO* uses three LEDs (modulated at 1 kHz) for source light. The source light enters the water volume and scattered material is detected by a detector positioned where the acceptance angle forms a 117-degree intersection with the source beam. Figure 3 shows the optical configuration for the *ECO*-BB2F.

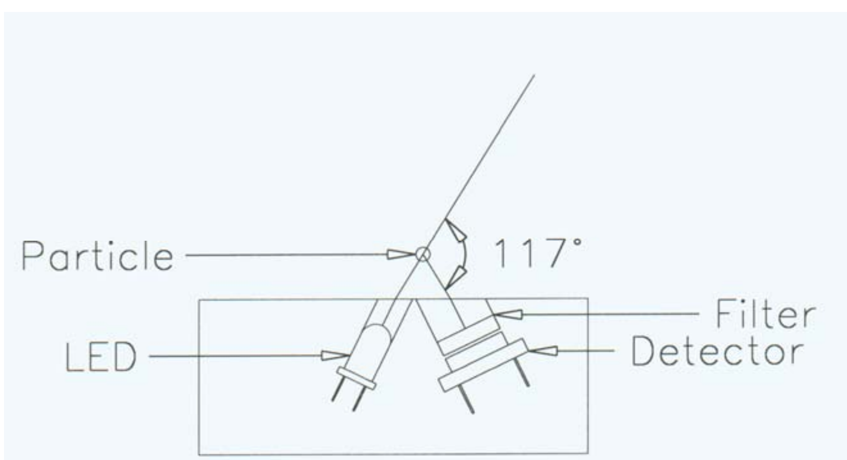


Figure 3. Optical configuration of *ECO*-BB2F scattering meter

3. Instrument Operation

Please note that certain aspects of instrument operation are configuration-dependent. These are noted where applicable within the manual.

3.1 Initial Checkout

The *ECO*-BB2F is typically configured for a measurement range of 0–5 m^{-1} (red), and 0–10 m^{-1} (blue). This is done at WET Labs by setting several gain settings inside the instrument and running a pure water blank to determine the zero voltage offset and to ensure that the dynamic range covers the measurement range of interest. As is the case with other scattering meters, a detailed calibration must be done by the user to determine the actual zero point and scale factor for his/her particular use. The techniques used to characterize the instrument are discussed in Section 6.

The *ECO*-BB2F is programmable, and as such, is flexible in start up and sampling capabilities. Supplied from the factory, BB2F is configured to begin continuously sampling upon power-on. The *ECO* sensors can be used in a moored or profiling mode, with or without a host computer/data logger. The *ECO*s are versatile instruments, capable of operating under a variety of user-selected settings.

To perform a basic operation check or to run the instrument in a simple benchtop configuration, one needs the instrument and a test cable. Insert a test or patch cable onto the bulkhead, align the pins and then push straight in without wiggling the cable from side to side. To remove the cable, grasp the body of the connector (not the wire) and pull straight out. (Many connectors are damaged by rocking the connector from side to side as they are pulled out.)

3.1.1 Connecting and Powering the Sensor

Electrical checkout of *ECO*-BB2F is straightforward.

Note

ECO scattering meters are sensitive to AC light. Before making measurement, turn AC lighting off.

1. Connect the battery leads on the test cable to the battery and connect the 6-connector pin to the instrument to provide power to the LEDs and electronics. Connect the DB-9 connector to a computer with the ECOView host program installed on it. Refer to the ECOView User's Guide for details about the software.

2. With the proper voltage applied to pin 1 and pin 4, light should emanate from the window on the sensor face. With the sensor face clean and dry the instrument should read approximately 50 counts.

WARNING!
Always use a regulated power supply to provide power to ECO sensors if not using the 9V battery provided with the test cable: power spikes may damage the meter.

3.1.2 Testing Output

Test the instrument's signal using a white card or your hand, held parallel to the face of the instrument. *ECO* is sensitive to room lighting. For best results, perform test in ambient light only (turn off AC lighting). The signal should be saturated at 4120 counts.

3.2 Deployment

Once power is supplied to the BB2F, the unit is ready for submersion and subsequent measurements. Some consideration should be given to the package orientation. Do not face the sensor directly into the sun or other bright lights. For best output signal integrity, locate the instrument away from significant EMI sources.

Caution
The BB2F should be mounted so that the red LED source will not "see" any part of a cage or deployment hardware. This will affect the sensor's output.

Other than these basic considerations, one only needs to make sure that the unit is securely mounted to whatever lowering frame is used and that the mounting brackets are not damaging the unit casing. The instrument can be used in a moored or profiling mode.

3.3 Upkeep and Maintenance

The *ECO*-BB2F is compact device and its maintenance can be easily overlooked. However, it is a precision instrument and does require a minimum of routine upkeep. After each cast or exposure of the instrument to natural water, flush the instrument with clean fresh water, paying careful attention to the sensor face. Use soapy water to cut any grease or oil accumulation. Gently wipe clean with a soft cloth. The sensor face is composed of ABS plastic and optical epoxy and can easily be damaged or scratched.

WARNING!
Do not use acetone or other solvents to clean the sensor.

At the end of an experiment, the instrument should be rinsed thoroughly, air-dried and stored in a cool, dry place.

4. BB2FB: Using Internal Batteries

ECO sensors powered with internal batteries can either run directly from the internal batteries or can operate from power supplied by an external DC power supply (7–15 volts). Internal-to-external source conversion is facilitated by a jumper plug that plugs into the unit's bulkhead connector. When inserted, the plug forms a connection from the battery to the electronics. By removing the plug, the instrument can be powered and communicate via a test or deployment cable. Setup conditions, instrument checkout, real-time operation, and data downloading are thus all achieved identically to the methods prescribed for the BB unit.

4.1 Removing End Flange and Batteries

WARNING!

Changing the batteries will require opening the pressure housing of the ECO sensor. Only people qualified to service underwater oceanographic instrumentation should perform this procedure. If this procedure is performed improperly, it could result in catastrophic instrument failure due to flooding or in personal injury or death due to abnormal internal pressure as a result of flooding.

WET Labs Inc. disclaims all product liability from the use or servicing of this equipment. WET Labs Inc. has no way of controlling the use of this equipment or of choosing qualified personnel to operate it, and therefore cannot take steps to comply with laws pertaining to product liability, including laws that impose a duty to warn the user of any dangers involved with the operation and maintenance of this equipment. Therefore, acceptance of this equipment by the customer shall be conclusively deemed to include a covenant by the customer to defend and hold WET Labs Inc. harmless from all product liability claims arising from the use and servicing of this equipment. Flooded instruments will be covered by WET Labs Inc. warranties at the discretion of WET Labs, Inc.

1. Make sure the instrument is thoroughly dry.
2. Remove the dummy plugs.
3. With connector end flange pointed downwards away from face, release seal from vent plug.
4. Remove moisture from vent plug area.
5. Using needle nose pliers, remove filament from end flange.
6. Lift flange from pressure housing until seal is broken. The jacking screws can be used to "push" the flange from the pressure housing and then can be removed or left in the end flange.
7. Remove any excess moisture from flange–can seal area.
8. Work end flange out of pressure housing and remove any residual moisture. Remove the gray foam spacer and the neoprene insulator.
9. The battery pack is connected to the processor boards by a six-pin Molex connector: do NOT pull too hard or far on the battery pack or it will come unplugged and the unit returned to WET Labs.

10. Gently pull the white cord at the loop to remove the battery pack from the pressure housing.
11. Remove the black plastic protectors from the ends of the long screws securing the batteries.
12. Loosen and remove the screws (3/16-in slotted driver).

4.2 Replacing End Flange and Batteries

1. Replace the batteries.
2. Re-install the screws:
    - Align the groove in each of the plates so the six-wire extension bundle will fit in it along its length.
    - Be careful not to cross-thread into the bottom end plate nor to over-tighten the screws.
    - If they are too tight, the fiber washers that act as separators between the batteries will flex.
    - Make sure there are equal amounts of screw threads protruding from the bottom end plate when they are secure. This will ensure the pack is straight and will fit into the pressure housing with no difficulty.
3. Re-install the black plastic protective covers on the ends of the screws.
4. Remove and check the pressure housing O-ring for nicks or tears. Replace if necessary. Before re-installing, apply a light coat of vacuum grease on the O-ring.
5. Carefully replace the battery pack in the pressure housing. Place the neoprene insulator on the battery assembly and lay the white cord on the top.
6. Plug in the two-pin, then the six-pin Molex connectors. Sensor operation can now be tested if desired.
7. Align the hole in the end flange (NOT the jack screw holes) with the white dowel pin. While coiling the six wire bundle and making sure none are pinched between the end flange and the pressure housing, position the flange on the housing. Leave space to re-insert the gray foam spacer, making sure the cut-out accommodates the vent plug screw.
8. Push the end flange all the way on to the pressure housing, making sure no wires are pinched. Be sure the vent plug does not pop up. If it does, you'll need to re-position the foam spacer.
9. Re-insert the monofilament.

4.3 Checking Vent Plug

If there is fouling on the vent plug, it should be cleaned and the two 010 O-rings replaced. Otherwise, this mechanism should be maintenance-free.

WARNING!
The pressure housing is made of plastic material that scratches easily. Do not let the screwdriver slip and scratch the can when removing or replacing the vent plug. Use a toothpick (something softer than the plastic) to remove the O-rings from the vent plug.

1. Pull vent plug out about half way; hold plug while unscrewing the truss screw. When screw is removed, pull vent plug from end flange.
2. “Pinch” bottom O-ring around vent plug to form a small gap you can work a toothpick into. Use the toothpick to help roll the bottom O-ring off the plug.
3. Perform the same procedure with the top O-ring.
4. Clean the vent plug and vent plug hole using a dry lint-free tissue or cotton swab.
5. Lightly coat two undamaged or new O-rings with silicon grease. Install the top O-ring (nearest to large end of plug) first, then the bottom one.
6. Insert vent plug into its hole in the end flange and hold it while inserting the truss screw. Rotate the vent plug to begin tightening the screw. Finish tightening using a screwdriver, being careful not to overtighten truss screw.

Note
A portion of the truss screw head has been removed to allow for venting in case of pressure buildup.

5. Data Analysis

Raw data from the BB2F is output as counts from the sensor, ranging from 0 to 4121. After the sensor is calibrated (i.e., subtracting the dark offset and multiplying by scaling factor—see Section 6), this data is now in the meaningful form of volume scattering coefficients, $\beta(\theta,\lambda)$ with units of m^{-1} sr^{-1}, where θ is angle and λ is wavelength. The ECO host program will automatically perform the necessary calculations.

5.1 Data Corrections

Attenuation coupling—For the population of photons scattered within the remote sample volume in front of the sensor face, there is attenuation along the path from the light source to the sample volume to the detector. This results in the scattering measurements being underestimates of the true volume scattering in the hydrosol. Corrected volume scattering coefficients can be obtained by accounting for the effect of attenuation along an average pathlength. This average pathlength was numerically solved in the weighting function determinations developed by Dr. Ron Zaneveld that are used in the calibration procedures.

Since the calibration of the *ECO*-VSF uses microspherical scatterers, the component of attenuation that can be attributed to scattering is incorporated into the scaling factor, i.e., the calibration itself. Thus, only absorption of the incident beam needs to be included in the correction.

The dependence on absorption, a, is determined as follows, where the measured scattering function at a given value of a, beta_meas(angle, a), is corrected to the value for a = 0 m^{-1}, beta_corr(117°, a=0):

beta_corr(117°, a=0) = beta_meas(117°, a) exp(0.0391a)

Absorption can be measured with an ac-9 device. For each ECO-BB2F wavelength, the matching absorption coefficient must be used from the ac-9. Because the *ECO*-BB2F incorporates short pathlengths and relatively small scattering volumes in its measurements, this attenuation error is typically small, about 4 percent at a = 1 m^{-1}.

Temperature correction—Output from an LED reference detector is provided, which gives an indication of relative LED intensity during operation. Work is presently under way to incorporate this signal as an ongoing correction for measurements. Largest expected deviations in the calibration coefficients are about 10 percent in the temperature range 0–28 degrees C. Note that these errors become more pronounced for very clear waters. If the instrument is planned for use in clear water environments at the ends of this temperature range, it is recommended that a request be made for calibration data to be collected as close to the expected environmental temperature as possible.

5.2 Derived Parameters

5.2.1 Volume Scattering of Particles

The corrected volume scattering of particles, $\beta(117°,\lambda)$ values represent total volume scattering, i.e., scattering from particles and molecular scattering from water. To obtain the volume scattering of particles only, subtract the volume scattering of water, $\beta_w(117°,\lambda)$:

$$\beta_p(117°,\lambda) = \beta(117°,\lambda) - \beta_w(117°,\lambda)$$

where $\beta_w(117°,\lambda)$ is obtained from the relationship (from Morel 1974):

$$\beta_w(\theta,\lambda)=1.38(\lambda/500\text{nm})^{-4.32}(1+0.3S/37)10^{-4}\ (1+\cos^2\theta(1-\delta)/(1+\delta))\text{m}^{-1}\text{sr}^{-1},\ \delta=0.09$$

where S is salinity.

For total scattering of pure water,

$b_w(\lambda) = 0.0022533\ (\lambda/500\text{nm})^{-4.23}$.

For total scattering of seawater (35–39 ppt),

$b_{sw}(\lambda) = 0.0029308\ (\lambda/500\text{nm})^{-4.24}$.

For backscattering by water, divide b_w or b_{sw} by 2. The units for the b coefficients are (10^{-4} m^{-1}).

5.2.2 Backscattering Coefficients

Particulate backscattering coefficients, $b_{bp}(\lambda)$ with units of m^{-1}, can be determined through estimation from the single measurement of $\beta_p(117°,\lambda)$ using an X factor:

$$b_{bp} = 2\pi\ X\ \beta_p(117°)$$

From measurements of the volume scattering function with high angular resolution in a diversity of water types, Boss and Pegau (2001) have determined X to be **1.1** (Boss, E., and S. Pegau, 2001. The relationship of scattering in an angle in the back direction to the backscattering coefficient, *Applied Optics*). This factor estimates b_{bp} with an estimated uncertainty of 4 percent. The conversion can be used for $\beta(117°)$ measurements made at any visible wavelength.

To compute total backscattering coefficients, $b_b(\lambda)$ with units of m^{-1}, the backscattering from pure water, $b_{bw}(\lambda)$ (see Table above), needs to be added to $b_{bp}(\lambda)$:

$$b_b(\lambda) = b_{bp}(\lambda) + b_{bw}(\lambda).$$

5.3 Digital Fluorometer Response

Digital data is processed in a similar fashion to analog data. Scaling is linear, and obtaining a "calibrated" output simply involves subtracting a digital offset value and multiplying the difference by the instrument scaling factor.

$$[XX]_{sample} = (C_{sample} - C_{blank}) * \text{Scale Factor}$$

where $[XX]_{sample}$ = Concentration of a sample of interest (µg/l)
C_{sample} = Raw counts output when measuring a sample of interest
C_{blank} = Measured signal in raw counts for a sea water blank
Scale factor = multiplier in µg/l-counts.

6. Testing and Characterization

Prior to shipment, each *ECO* is tested and characterized to ensure that it meets the instrument's specifications.

6.1 Testing

When the instrument is completely assembled, it goes through the tests below to ensure performance.

6.1.1 Pure Water Blank

Pure, de-ionized water is used to set the "zero" level of the meter. This zero level is set for 50 counts (+/-15) on all models.

6.1.2 Pressure

To ensure the integrity of the housing and seals, ECOs are subjected to a wet hyperbaric test before final testing. The testing chamber applies a water pressure of at least 50 PSI.

6.1.3 Mechanical Stability

Before final testing, the ECO-BB2F meters are subjected to a mechanical stability test. This involves subjecting the unit to mild vibration and shock. Proper instrument functionality is verified afterwards.

6.1.4 Electronic Stability

This value is computed by collecting a sample once every 5 seconds for twelve hours or more. After the data is collected, the standard deviation of this set is calculated and divided by the number of hours the test ran. The stability value must be less than 2.0 counts/hour.

6.1.5 Resolution

Resolution is computed from a standard deviation over 60 samples, collected at one-second intervals for one minute. The standard deviation is calculated on the 60 samples, and the result is the published resolution on the calibration sheet. The calculated standard deviation value must be below 3 counts

6.1.6 Voltage and Current Range Verification

To verify that the *ECO* operates over the entire specified voltage range (7–15V), a voltage-sweep test is performed. *ECO* is operated over the entire voltage range, and the current and operation is observed. The current must remain constant at approximately 85 mA over the entire voltage range.

6.2 Fluorometer Characterization

Gain selection is performed at WET Labs by setting several gain settings in the instrument and running a chlorophyll (or proxy) dilution series to determine the zero voltage offset and to ensure that the dynamic range covers the measurement range of interest. The dilution series also establishes the linearity of the instrument's response.

6.3 Scattering Meter Calibration

Each meter ships with a calibration sheet that provides instrument-specific calibration information, derived from the steps below.

1. For a given scattering centroid angle (θc), compute the weighting function W(θ,θc), by numerical integration of sample volume elements according to the sensor geometry.

2. Determine scattering phase functions, β(θ, λ)/b(λ), for the polystyrene bead microsphere calibration particles by weighting volume scattering functions computed from Mie theory according to the known size distribution of the polystyrene bead microsphere polydispersion and normalizing to total scattering.

3. By convolving W(θ,θ c) with β(θ, λ)/b(λ), compute the normalized volume scattering coefficient for each measurement angle, β(θ, λ)/b(λ), with units of sr^{-1} β(θc)/b for 2.00-micron diameter polystyrene bead microspheres.

4. Experimentally obtain raw scattering counts simultaneously with attenuation coefficients (C_p, using an ac-9) for a concentration series of the polystyrene bead microsphere polydispersion. Absorption by the calibration particles is assumed negligible.

5. Obtain b/counts from the slope of a linear regression between Cp (equivalent to b for the beads) and counts.

6. Multiplying the experimental b/counts by the theoretical β(θc)/b yields the calibration scaling factor, SF.

7. To obtain β(θc), subtract the dark counts from the raw counts measured, then multiply by SF.

8. This test also provides a measure of the inherent opto-electronic noise level of the instrument.A standard deviation from the average number of counts on a 1 minute data file is taken. This is translated into the resolution of β(θc) (minimum detectable signal change) in units of m^{-1} sr^{-1}.

Definitions of Terms

β: phase function	**b**: total scattering coeficient
θ: angle	**θc**: centriod angle
W: weighting function	**λ**: wavelength
Cp: particulate attenuation coefficient	**SF**: Scaling Factor
m^{-1}: per meter	**sr^{-1}:** per steradian

7. Terminal Communications

As an alternative to the ECOView host software, *ECO* sensors can be controlled from a terminal emulator or customer-supplied interface software. This section outlines hardware requirements and low-level interface commands for this type of operation.

7.1 Interface Specifications

- baud rate: 19200
- data bits: 8
- parity: none
- stop bits: 1
- flow control: none

7.2 Command List

Command	Parameters passed	Description
!!!!!	none	Stops data collection; allows user to input setup parameters. Note that if the meter is in a sleep state, the power must be turned off for a minute, then powered on while the "!" key is held down for several seconds. If this does not "wake" the meter, refer to the ECOView user's guide Operation Tip to "wake" a meter in a low power sleep state to enable inputting setup parameters.
$asv	1, 2, or 4	Analog scaling value. Counts will be divided by this for analog output: a value of 4 will make the analog output cover the whole output range; 2 will cover half, and 1 will cover only the bottom fourth of the 14-bit count range (fluorometers only).
$ave	single number, 1 to 65535	Number of measurements for each reported value
$clk	24hr format time, hhmmss	Sets the time in the Real Time Clock
$dat	date, format ddmmyy	Sets the date in the Real Time Clock
$emc	none	Erases the Atmel memory chip, displays menu when done
$get	none	Reads data out of Atmel memory chip. Prints "etx" when completed.
$int	24hr format time, hhmmss	Time interval between packets in a set
$mnu	none	Prints the menu, including time and date
$pkt	single number, 0 to 65535	Number of individual measurements in each packet
$rec	1 (on) or 0 (off)	Enables or disables recording data to Atmel memory chip
$rls	none	Reloads settings from flash
$run	none	Executes the current settings
$set	single number, 0 to 65535	Number of packets in a set
$sto	none	Stores current settings to internal flash
$ugl	0 to 255	µg/l conversion value (calculates slope x 10,000). Fluorometer only.

8. Device Files

The ECOView host program requires a device file to provide engineering unit outputs for any of its measurements. Except for the first line in the device file, all lines of information in the device file that do not conform to one of the descriptor headers will be ignored. Every ECOView device file has three required elements.

8.1 Plot Header

The first line in the device file is used as the plot header for the ECOView plots.

8.2 Column Count Specification

The Column Count Specification identifies how many columns of data to expect. It follows the format “Column=n.” The Column Count Specification must be present before any of the Column Descriptions are listed.

8.3 Column Description

Every column in the ECO meter’s output must have a corresponding Column Description in the device file.The following notation is used in identifying the elements of each Column Description.

x = the column number, starting with 1 as the 1st column
sc = scale
dc = dark count: meter output in air with optics head taped
off = clean water offset, meter output in clean water
mw = wavelength measured by the sensor
dw = display wavelength—color to plot the BB data in
v = measured volts dc

Valid Column Descriptions are listed in the subsections below.

8.3.1 Scattering Measurements

Lambda=x	sc	off	mw	dw	Scatter sensor column

8.3.2 Miscellaneous

Date=x	DD/MM/YY
Time=x	HH:MM:SS
REF=x	Reference Counts—Currently not used by ECOView
N/U=x	The column is Not Used

There are several defaulted parameters that ECOView uses in the scatter calculations for the BB meters. These parameters are (a) salinity; (b) water type, fresh or sea water; (c) Chi ; and (d) theta, the measurement angle. The user may change these using the following device file elements (the values shown are the defaults).

Salinity=32 32 ppt
Water=SeaMeter is assumed to be in salt water (Use "Pure" for fresh water)
XFactor=1.1 X Factor Correction Value
Theta=117 Back scattering angle

8.3.3 Sample Device File

An instrument-specific device file is shipped with each BB meter and has the following format, where xxx is the serial number of the instrument.

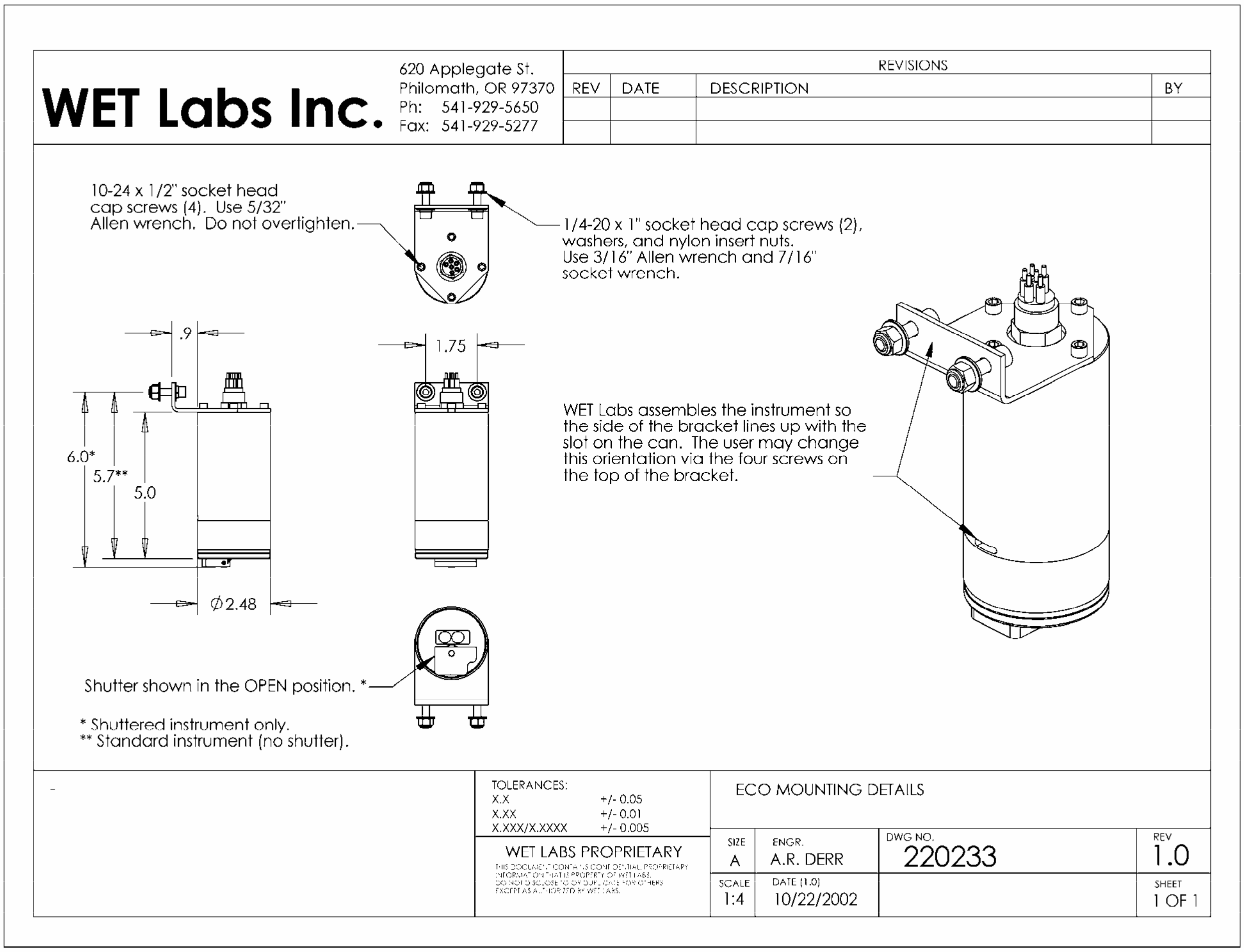
```
ECO BB2F-xxx
Created on: 9/20/02

Columns=8
Date=1
Time=2
REF=3
Lambda=4  0.0026  51.0 470  470
REF=5
Lambda=6  0.0011  55.5 650  650
CHL=7     0.0181    48.0
iTemp=8   -0.6793 395.94
```

8.4 Output File

Below is a sample output file for a BB2F.

Date	Time	Beta(470)	Betap(470))	bbp(470)	bb(470))	Beta(650)	Betap(650)	bbp(650)	bb(650))	CHL(ug/l)	iTemp(C)
39	39	-0.033800	-0.034066	-0.235441	-0.233536	0.026950	0.026884	0.185806	0.186288	0.3439	27.0801
40	40	-0.039000	-0.039266	-0.271380	-0.269475	0.030250	0.030184	0.208614	0.209095	0.1629	27.0801
41	41	-0.028600	-0.028866	-0.199502	-0.197597	0.026950	0.026884	0.185806	0.186288	0.2172	27.0801
42	42	-0.028600	-0.028866	-0.199502	-0.197597	0.030250	0.030184	0.208614	0.209095	0.3439	27.0801
43	43	-0.036400	-0.036666	-0.253411	-0.251506	0.024750	0.024684	0.170601	0.171083	0.1629	27.7594
44	44	-0.028600	-0.028866	-0.199502	-0.197597	0.023650	0.023584	0.162999	0.163481	0.2172	27.0801

Appendix A: Mounting Bracket Drawing



Revision History

Revision	Date	Revision Description	Originator
A	10/15/02	New document (DCR 242)	W. Strubhar, D. Whiteman
B	10/23/02	Add mounting hardware description (DCR 251)	A. Derr
C	2/10/03	Delete lithium battery warning (DCR 272)	D. Whiteman
D	03/03/03	Add Terminal Communications section (DCR 283)	I. Walsh
E	04/14/03	Add stop command to terminal communications (DCR 292)	W. Strubhar
F	5/29/03	Clarify equations in section 5.2.1 (DCR 303)	M. Twardowski
G	8/6/03	Add to deliverables list, correct references in Data Analysis, update device files (DCR 321)	H. Van Zee
H	9/8/03	Add calibration details from calibration sheet to user's guide (DCR 332)	D. Hankins, H. Van Zee, I. Walsh
I	11/24/03	Modify explanation for stop data collection command (DCR 342)	W. Strubhar
J	11/25/03	Update specifications (DCR 338)	I. Walsh
K	2/5/04	Correct salinity value (DCR 365)	I. Walsh, D. Romanko
L	2/17/04	Update column description for device files (DCR 367)	I. Walsh